

DETAILED ACTION

1. This office action is responsive to communications filed 4/27/2009, personal interview of 11/10/2009, and telephonic interview of 12/8/2009.
2. Claims 3, 5, and 18 were previously cancelled. Claims 1, 2, 4, 7-9, 13-17 are currently amended.
3. An examiner's amendment to the record appears below. Should the changes and/or additions be unacceptable to applicant, an amendment may be filed as provided by 37 CFR 1.312. To ensure consideration of such an amendment, it MUST be submitted no later than the payment of the issue fee.
4. Authorization for this examiner's amendment was given in a telephone interview with Applicant's representative, Dan Tanner, Esq. (Reg. No. 54,734) on 12/8/2009
5. The applicant has agreed to the following Examiner's Amendments:

Claims

1. (Currently Amended) A method of routing ~~one or more~~ at least one information query from one or more ~~arbitrary~~ sensor network entry points in a network of sensor nodes to one or more destination nodes in a vicinity of physical phenomena of interest in the network, the method comprising:

selecting a destination node by computing a utility of a plurality of network sensor nodes and selecting a node with highest utility to be the destination node wherein the computed utility indicates information gain;

establishing a leader node;

using a multiple step lookup procedure to determine ~~an optimum~~ a path between the leader node and the destination node that is optimum with respect to utility; and

routing at least one information query to the destination node based on the ~~determined optimum~~ path,

a locus of all possible paths from a current node in the path to the destination node that can be traversed within a specified path length forms an ellipse with the destination node as one focus point and the current node as another focus point, the ellipse is sampled with four candidate points,

a maximum utility among four paths corresponding to the four candidate points, is assigned as the utility of the ellipse; and the four paths start at the current node, end at the destination node, and traverse one of the ellipse's minor axis or major axis

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2. (Currently Amended) A method of routing an information query of claim 1, wherein the multiple step lookup procedure comprises: determining a minimum number of hops required to reach the destination node from the leader node;
determining all possible paths of the minimum number of hops or less from the leader node to the destination node;
determining the utilities of all possible minimum number of hops paths;
selecting a minimum number of hops path that traverses nodes the sum of whose utilities is the greatest; and
selecting a first node in the selected minimum number of hops path and passing leadership from the leader node to the first node, wherein the first node becomes the leader node
3. (Cancelled)
4. (Currently Amended) A system to route information via a network of sensor nodes from a leader node to a destination node, the system comprising:
a destination node selection mechanism that determines a utility of a plurality of nodes and selects a node with a highest utility to be the destination node; wherein the determined utility indicates information gain;
establishing a leader node;
a processing mechanism that determines a minimum number of hops required to reach the destination node from a current leader node;
a processing mechanism that determines a number of possible paths within a specified number of hops or less from the current leader node to the destination node;

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a path selection mechanism that selects ~~an m-hop~~ a minimum hop path that traverses nodes the sum of whose utilities is the greatest; and

a selection mechanism that selects a first node in the selected ~~m-hop~~ minimum hop path and passes leadership from the current leader node to the first node, wherein the first node becomes the current leader node

a locus of all possible paths from a current node in the path to the destination node that can be traversed within a specified path length forms an ellipse with the destination node as one focus point and the current node as another focus point, the ellipse is sampled with four candidate points,

a maximum utility among four paths corresponding to the four candidate points, is assigned as the utility of the ellipse; and the four paths start at the current node, end at the destination node, and traverse one of the ellipse's minor axis or major axis

5. (Cancelled)

6. (Previously Presented) The system of claim 4, further comprising: a leadership transfer mechanism that changes leadership from one node to another node.

7. (Currently Amended) A point-to-point ~~query~~ routing method for routing a query via a network of sensor nodes including a source sensor node and a destination sensor node, the method comprising:

selecting a source sensor node and a destination sensor node;

establishing a neighborhood around the source sensor node;

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determining costs associated with communication that has already occurred along paths to ~~neighborhood~~ sensor nodes in the neighborhood around the source sensor node and costs associated with going forward along paths to sensor nodes in the neighborhood of around the source sensor node;

determining information gain based on network sensor nodes already visited for a number of paths in the neighborhood around the source sensor node and to be visited for a number of paths in the neighborhood around the source sensor node; and

conducting an RTA* type forward search to relay a query from the ~~entry~~ point source sensor node to the destination sensor node point based on the determined cost and the determined information gain,

a locus of all possible paths from a current node in the path to the destination sensor node that can be traversed within a specified path length forms an ellipse with the destination sensor node as one focus point and the current node as an other focus point, the ellipse is sampled with four candidate points,

a maximum utility among four paths corresponding to the four candidate points, is assigned as the utility of the ellipse; and the four paths start at the current node, end at the destination sensor node, and traverse one of the ellipse's minor axis or major axis

8. (Currently Amended) A method of routing information about the location of an event via a network of sensor nodes including a leader node and a destination node, the method comprising:

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selecting a destination ~~location~~ node by computing a utility of a plurality of nodes and selecting a node with a highest utility to be the destination node;

wherein the ~~computed~~ utility indicates information gain

establishing a leader node;

determining a minimum number of hops required to reach the destination ~~location~~ node from the leader node;

determining all possible paths within a specified number of hops or less from the leader node to the destination node;

selecting a path within a specified number of hops or less from the leader node to the destination node that traverses nodes the sum of whose utilities is the greatest; ~~and~~

selecting a first node in the selected path and passing leadership from the leader node to the first node, wherein the first node becomes the leader node

a locus of all possible paths from a current node in the path to the destination node that can be traversed within a specified path length forms an ellipse with the destination node as one focus point and the current node as an other focus point, the ellipse is sampled with four candidate points,

a maximum utility among four paths corresponding to the four candidate points, is assigned as the utility of the ellipse; and the four paths start at the current node, end at the destination node, and traverse one of the ellipse's minor axis or major axis

9. (Currently Amended) A method of routing a query about a location of an event of interest via a network of sensor nodes, the method comprising:

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determining a source sensor node;
establishing a neighborhood around the source sensor node;
determining communication costs, including costs associated with communication that has already occurred along paths to ~~neighborhood~~ sensor nodes in the neighborhood around the source sensor node and costs associated with going forward along paths to sensor nodes in the neighborhood around the source sensor node;

determining information gain based already visited for a number of paths to sensor nodes in the neighborhood around the source sensor node and to be visited for a number of paths to sensor nodes in the neighborhood around the source sensor node;

forming a belief state about the ~~event~~ location of the event of interest based on the determined communication costs and determined information gain;

determining a destination based on the location of an event of interest

routing the query based on the belief state, wherein a locus of all possible paths from a current node in the path to the destination ~~node~~ that can be traversed within a specified path length forms an ellipse with the destination ~~node~~ as one focus point and the current node as an other focus point,

the ellipse is sampled with four candidate points, a maximum utility among four paths corresponding to the four candidate points, is assigned as the utility of the ellipse; and the four paths start at the current node, end at the destination, and traverse one of the ellipse's minor axis or major axis

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10. (Original) The system of claim 4, wherein the sensor nodes comprise different types of sensors.

11. (Original) The system of claim 4, wherein the sensor nodes comprise acoustic sensors.

12. (Original) The system of claim 4, wherein the sensor nodes comprise seismic sensors.

13. (Currently Amended) A method of information-directed query routing along a path from a source node to a destination node in a network of sensor nodes, the method comprising:

selecting a source sensor node and a destination sensor node;

determining a path from the source node to the destination node that is more efficient in terms of communication cost than other paths from the source node to the destination node; and

maximally aggregating gain of information about an event along the path; and routing the a query based on the determined cost and aggregated information gain, wherein

a locus of all possible paths from a current node in the path to the destination node that can be traversed within a specified path length forms an ellipse with the destination node as one focus point and the current node as an other focus point, the ellipse is sampled with four candidate points,

a maximum utility among four paths corresponding to the four candidate points, is assigned as the utility of the ellipse; and the four paths start at the

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current node, end at the destination node, and traverse one of the ellipse's minor axis or major axis

14. (Currently Amended) A method of point-to-point routing of query information regarding a phenomenon of interest in a sensor network having a plurality of sensor nodes along a path from an ~~arbitrary~~ entry point node to an ~~arbitrary~~ exit point node, the method comprising:

establishing a leader node;

maximally aggregating information about a phenomenon of interest along ~~the~~ a path from an entry point node to an exit point by estimating information expected to be gained from the entry node to the exit point node;

selecting a successor leader node based on the estimated information expected to be gained;

routing ~~the~~ query information based on the maximally aggregated information, wherein

a locus of all possible paths from a current node in the path to the ~~destination~~ exit point node that can be traversed within a specified path length forms an ellipse with the ~~destination~~ exit point node as one focus point and the current node as an other focus point, the ellipse is sampled with four candidate points,

a maximum utility among four paths corresponding to the four candidate points, is assigned as the utility of the ellipse; and the four paths start at the current node, end at the exit point, and traverse one of the ellipse's minor axis or major axis

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15. (Currently Amended) The method of claim 14, wherein estimating the information expected comprises establishing and moving a frontier and iteratively expanding nodes on the frontier until the exit point ~~node~~ is reached.

16. (Currently Amended) The method of claim 14, further comprising: obtaining network node sensor measurements to refine target estimates of the exit point wherein the ~~arbitrary~~ exit point is the location of an event of interest.

17. (Currently Amended) The method of claim 13, wherein maximally aggregating gain of information about the event of interest along the path comprises finding a path that includes detours around sensor network holes and at least one path ending.

18. (Cancelled)

Reasons For Allowance

5. The following is an examiner's statement of reasons for allowance. Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

6. Claims 1, 2, 4, 6-17 are allowed. Prior art fails to disclose the claimed limitations of claims 1, 4, 7-9, 13, 14 of:

routing an information query in a sensor node network to a destination node based on the determined optimum path, wherein a locus of all possible paths from a current node to the destination node that can be traversed within a specified path length forms an ellipse with the destination node as one focus point and the current node as an other focus point, the ellipse is sampled with four candidate points,

a maximum utility among four paths corresponding to the four candidate points, is assigned as the utility of the ellipse; and

the four paths start at the current node, end at the destination node, and traverse one of the ellipse's minor axis or major axis

7. It was well-known in the art at the time of the invention to determine an optimal path in ad-hoc sensor networks using Constrained anisotropic diffusion routing (CADR) and/or Information-driven sensor querying (ISDQ) techniques (see e.g. Chu et al. *SCALABLE INFORMATION-DRIVEN SENSOR QUERYING*

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AND ROUTING FOR AD HOC HETEROGENEOUS SENSOR NETWORKS, The International Journal of High Performance Computing Applications, Vol. 16, No. 3, (Fall 2002): p.293 §1) and by successively selecting traversing nodes within an elliptical area around the current node (see e.g. Chu: §§2.1, 4.2).

However, Applicant's invention is distinguishable on the basis of not only combining CADR and ISDQ techniques, but also by forming the ellipse with the destination node and the current node focal points of the ellipse, wherein the ellipse is sampled with four candidate points, and a maximum utility among four paths corresponding to the four candidate points is assigned as the utility of the ellipse and thus as the utility of the candidate paths for purposes of determining maximum utility.

8. Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to ROBERT SHAW whose telephone number is (571) 270-5643. The examiner can normally be reached on 9:30am- 6:30pm Monday-Thursday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Saleh Najjar can be reached on (571) 272-4006. The fax

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phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/R. S./
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